

# On-Orbit Health Monitoring and Repair Assessment of Thermal Protection Systems, Phase I

Completed Technology Project (2005 - 2005)



## Project Introduction

This SBIR project delivers On-orbit health MoNItoring and repair assessment of THERMal protection systems (OMNI\_THERM). OMNI\_THERM features impedance-based structural health monitoring (SHM) and uses miniaturized autonomous sensor/actuators to diagnose damage and verify repair efficacy. Implications of the innovation Thermal protection systems are crucial for crew safety. New techniques of on-orbit monitoring and assessment of thermal protection structures are needed for space exploration. An autonomous impedance-based SHM system is one of the few viable solutions; however, this technique has not been applied to thermal protection systems. Technical objectives OMNI\_THERM deploys autonomous, wireless, self-powered sensor/actuators that harvest energy from vibration and thermal gradients. Each sensor/actuator is a complete SHM system and reports independently; this computationally distributed framework minimizes single points-of-failure. We have built a prototype, performed SHM on launch support structures, and demonstrated repair assessment. Research description Phase I demonstrates OMNI\_THERM SHM on reinforced carbon-carbon (RCC) and other model structures. Phase II includes miniaturization and expands OMNI\_THERM capabilities to additional thermal materials, hybrid structures, and advanced composites. Anticipated results Phase I establishes feasibility by detecting cracks, gouges, and stress-induced defects in RCC and other model structures and verifying repairs. Phase II delivers an OMNI\_THERM system tailored to on-orbit SHM and repair assessment.

## Anticipated Benefits

Commercial applications include Homeland Security structural analysis to mitigate threats (preparedness) and assess damage (response), smart structures, and SHM of nuclear plants, aircraft, dams, and bridges. SHM is an emerging industry driven by an aging infrastructure, malicious humans, and the introduction of advanced materials. Government customers include the Federal Highway Administration and the Departments of Defense, Transportation, and Energy. Non-government customers include oil and gas companies, and other crucial-structure custodians. Westinghouse Electric Company (Nuclear Services Division) is our commercialization partner. WEC sees OMNI\_THERM applications in nuclear power plants, and provides engineering and marketing support at no cost. The Exploration Systems Enterprise will develop and use increasing sophisticated hardware and systems. Sustainable and flexible space exploration requires reliable structural assessment on-orbit and in-flight to guide hardware maintenance and servicing and verify repair efficacy for complex structures. Thermal protection systems directly support crew safety and are among the most crucial structural elements. These complex structures and materials must withstand severe stresses and hostile aero-thermo-chemical environments. They are also vulnerable to micrometeor damage and must be continuously monitored and repeatedly reassessed. Lightweight, compact, and reliable SHM technology is



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## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Center / Facility:

Langley Research Center (LaRC)

### Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

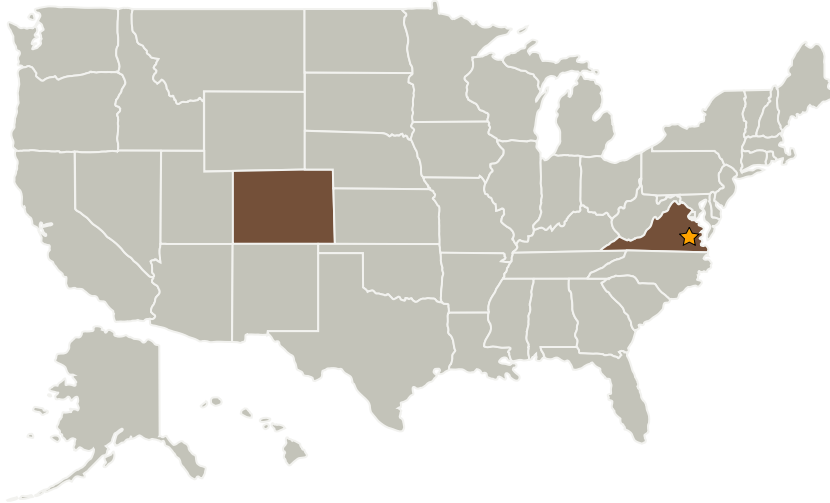
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needed to autonomously inspect and diagnosis advanced thermal protection systems.

## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
Extreme Diagnostics, Inc.	Supporting Organization	Industry	Boulder, Colorado

## Primary U.S. Work Locations

Colorado	Virginia
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## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Project Manager:**

William C Wilson

**Principal Investigator:**

Robert B Owen

## Technology Areas

**Primary:**

- TX14 Thermal Management Systems
  - └ TX14.3 Thermal Protection Components and Systems
    - └ TX14.3.5 Thermal Protection System Instrumentation